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PROCEDURE FOR THE DETERMINATION OF DENSITY OF LIQUID FUELS BY DIGITAL DENSITY METER

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1 Introduction

- 1.1 This document describes an automated method of measuring the density of liquid fuels using a digital density meter.
- 1.2 This test method covers liquid fuels (i.e. gasoline and diesel fuel) which are liquids at 60 °F with vapor pressures below 600 Torr and viscosities below 15000 mm²/s at 60 °F.
- 1.3 This procedure is based on ASTM D 4052-91.¹

2 Method

- 2.1 A small volume (approximately 0.7 mL) of liquid sample is introduced into the density meter's oscillating sample tube.
- 2.2 The change in the oscillating frequency of the tube caused by the increased mass of the tube is used in conjunction with calibration data to determine the density of the sample.

3 Instrumentation

- 3.1 Digital Density Meter: Anton-Paar model DMA 48.
- 3.2 Sample Loading Equipment
- 3.2.1 Luer cone syringes.
- 3.2.2 Optional filling and rinsing system (FRS).
- 3.2.3 Tygon brand fuel resistant tubing F-4040-A.

4 Reagents

4.1 Methanol, A.C.S. reagent grade or better.

- 4.2 Isooctane, A.C.S. reagent grade or better.
- 4.3 Deionized water.

5 Preparation of Instrument

5.1 The instrument should be set to 60 °F (15.56 °C) for at least an hour before calibration or analyses are performed.

6 Calibration

- 6.1 Calibration (also referred to as adjustment) must be performed at least once per year, and any time the instrument undergoes a master reset. A record of instrument physical constants, called an "adjustment report", is kept and updated every time an adjustment is performed.
- Using a Luer tip syringe, fill the cell with a solvent suitable for cleaning out sample residue (e.g. hexane for gasoline, hexadecane for diesel).
- 6.2.1 If a heavy solvent such as hexadecane was used, repeat step 6.2 with a lighter solvent such as hexane.
- 6.3 Attach the instrument's air hose to the measuring cell. Turn on the air pump and let dry air blow through the cell for at least 10 minutes. Turn off the air pump and remove the air hose from the cell.
- 6.4 Examine the measuring cell for any signs of dirt or moisture. If the cell does not appear clean and dry, repeat steps 6.2 and 6.3.
- 6.5 Wait until the instrument is stable (the front-panel X does not flash).
- 6.6 Press "F500" on the DMA 48 keyboard to set the display to oscillation period.
- 6.7 Press "F100" to start the air adjustment routine.
- 6.8 Enter the correct air density obtained in appendix G of the DMA 48 manual.² The ambient temperature and atmospheric pressure must be known.

- 6.9 Wait until the front-panel X stops flashing.
- 6.10 Note down the oscillation period of the measuring cell for the adjustment report.
- 6.11 Using a Luer tip syringe, fill the measuring cell with deionized water.
- 6.12 Check the measuring cell for bubbles. If there are bubbles, remove the water, rinse the cell with methanol, dry the cell (see 6.3) and repeat 6.11.
- 6.13 After the X stops flashing, press "F101". Acknowledge the instrument's value for the density of water at the measuring temperature and press return.
- 6.14 Wait until the X stops flashing.
- 6.15 If this is the first adjustment at the measuring temperature since a master reset, the display should read a number between 1.3 and 1.6.
- 6.16 If this is not the first adjustment, the number on the display (deviation B) should read between -0.0002 and +0.0002.
- 6.17 If the number on the display is outside these ranges, the entire adjustment process needs to be redone. Press "CLR". Begin again at 6.2. If the deviation B number is within 0.0002 of the previously obtained number, then the adjustment is valid. If not, the reason for the instrument's instability must be determined.
- 6.18 Before removing the water from the measuring cell:
- 6.18.1 Note the oscillation period of the cell (F500) for water in the adjustment report.
- 6.18.2 Note the constants A and B to 5 places after the decimal point (F110) for the adjustment report.
- 6.19 Rinse the measuring cell with methanol and dry it with air using the built-in air pump.

7 Procedure

7.1 If the optional filling and rinsing system (FRS) is used, set it up as shown in the FRS manual³. Methanol should be used for both solvent rinses. All tubing should be fuel resistant Tygon or

- Teflon. The FRS is not to be used for diesel samples.
- 7.2 If the FRS is being used, the correct command must be entered into the instrument. See the FRS manual for details. Under ordinary conditions, this number is never changed.
- **7.3** Sample Loading
- 7.3.1 If the FRS is being used, place the inlet hose into a large quantity of the sample (preferably the original container). Activate the FRS by pressing "*". After the sample is finished loading, immediately move the inlet hose into an appropriate waste container.
- 7.3.2 If the FRS is not being used, use a Luer tip syringe to fill the measuring cell with the sample.
- 7.4 Check the measuring cell for the presence of bubbles. If bubbles are present, remove the sample from the cell (press the CLR key if the FRS is being used) and repeat 7.3.
- 7.5 Wait until the display starts flashing to record the sample density.
- 7.6 If the FRS is being used, the instrument will automatically was the cell with methanol and dry it. If not, clean the cell with methanol and dry it as described in 6.2-6.4 above.
- 7.7 After air drying is complete, the next sample may be analyzed.

8 Quality Control

- 8.1 At the beginning of a set of samples, the density of pure isooctane is measured.
- 8.2 The measured density of isooctane should differ by no more than 0.0003 g/mL from the accepted literature value. At 15.56° C, the usual measuring temperature, the specific gravity of isooctane is 0.6963⁴. This value corresponds to a density of 0.6955 g/mL. Note that density is extremely sensitive to sample contamination. Any contamination of the isooctane may lead to erroneous results.
- 8.3 If the measured density of isooctane falls outside the acceptable range, the instrument cell should be carefully cleaned and dried. If a second analysis still fails, a new bottle of isooctane should be opened. If the third analysis fails, the instrument should be recalibrated.

9 References

- 1. "Standard Test Method for Density and Relative Density of Liquids by Digital Density Meter," *Annual Book of ASTM Standards*, Vol 05.02.
- 2. "DMA 48 Density / Specific Gravity / Concentration Meter Instruction Handbook," Anton Paar, Graz, Austria, 1995.
- 3. "FRS Filling and Rinsing System Instruction Handbook," Anton Paar, Graz, Austria, 1995.
- 4. APhysical Constants of Hydrocarbons C1-C10, Special Technical Publication 109A, American Society for Testing and Materials.